is unnecessary. The chapters on the absorption and assimilation systems are considerably enlarged, the former by a paragraph on the absorption of water by the hairs of foliage leaves. The chapter on the conducting system is also much enlarged, the author giving an exposition of the theories of water conduction and explaining the present status of our knowledge of this difficult and perplexing subject. Another section of the same chapter illustrates the author's idea of the dependence of form upon function, that is, that organs are called into existence by some special need of the plant. In this connection he gives an hypothesis concerning the probable manner of development of the different kinds of bundles.

The chapter on apparatus for special purposes contains a description of the various means of plant motion. The passive organs are the flying and swimming tissues which are fully described and illustrated. The active tissues are described as hygroscopic and living, the latter including those through which movements are caused by outer stimuli. The tissues supposed to receive stimuli and those designed only for their conduction are fully treated.

In style the book is exceedingly clear and attractive, and the principles upon which its method of treatment rests are now admitted by all. It is questioned by some, however, whether this classification of tissue systems should be substituted for the older and simpler one which is now in general use. The objections are that it presupposes at least a partial knowledge of the tissues, and that it is too extended to find a place in a text-book on general botany. Both of these objections have more weight perhaps in this country than in Germany. It is also true that the simpler method is far more practical for students of pharmacy and medicine, and for any others who wish only a general view of this branch of botany. In view of these considerations it would seem wiser for us, at least, to precede such a view as Haberlandt presents by a general view based simply upon didactic principles.—EMILY L. GREGORY.

NOTES FOR STUDENTS.

THE ACTION of the yeast cell during alcoholic fermentation has always been a difficult matter for the physiologist to explain. Most writers for the last twenty-five years have considered fermentation a specific form of protoplasmic activity, possessed by certain species of lower plants in a highly developed form. The view of Traube (1858) and of Hoppe-Seyler, ascribing fermentative action to an albuminoid compound secreted by the yeast cell, allied in its nature to the enzymes, has never found favor with botanists. Nägeli in his carefully considered theory of fermentation (1879) pointed out very important differences between the behavior of so-called organized and unorganized ferments, and laid particular stress upon the fact that it had

been found impossible to separate any substance from yeast or other organized ferment that would produce an alcoholic fermentation independent of living protoplasm. Sachs has also elaborated the same opinion. The problem has been further complicated by the assumption by Pfeffer, Wiesner, Noll, and others, that alcoholic fermentation is identical with intramolecular breathing, and therefore through a series of gradations with normal breathing.

A discovery which promises to be of great importance in this connection was announced by Dr. Eduard Buchner[6] of Tübingen in a preliminary communication to the German Chemical Society on January 11. He has separated a nitrogenous compound from yeast which produces a vigorous and characteristic alcoholic fermentation without the presence of yeast or bacteria cells, *i. e.*, independent of living protoplasm.

The method pursued in separating the ferment was as follows. A thousand grams of pure compressed yeast were mixed with an equal weight of quartz sand and 250 grams of diatomaceous earth and the whole ground together until the mass became moist and plastic. This was mixed with 100^{cc} of water and then subjected to a pressure of four to five hundred atmospheres in a hydraulic press. By this means about 300^{cc} of liquid was secured. The remaining cake was broken up and mixed with 100^{cc} of water, and being pressed as before yielded about 150^{cc} additional liquid, which was added to the first. The liquid, being somewhat turbid, was shaken up with 4 grams of diatomaceous earth and filtered through paper several times.

A clear liquid was thus obtained having a specific gravity at 17°C. of 1.0416 and yielding a large percentage of dry substance. By microscopic and bacteriological tests it was found to be absolutely free from yeast cells, and almost or quite free from all other germs.

When this extract is added to an equal amount of a strong solution of either cane, grape, or invert sugar, a vigorous fermentation starts up after a quarter of an hour to an hour and continues for days. There is no action, however, with lactose or mannite, substances which do not ferment with living yeast. The fermentation is not prevented by the presence of chloroform. The liquid lost its fermentative action in a low temperature after five days, but in presence of cane sugar kept it for two weeks under otherwise the same conditions. When heated to 50°C. a flocculent precipitate forms and the power of fermentation is lost. When precipitated with alcohol and dried over sulfuric acid it became inactive. The active principle appears to be incapable of dialysis, but its exact behavior in this regard has not yet been determined.

The author believes that he has demonstrated that alcoholic fermentation is a chemical change, carried on independent of living protoplasm by means of a characteristic proteid substance, for which he proposes the name *zymase*.

[6] BUCHNER, EDUARD: Alkoholische Gärung ohne Hefezellen. Ber. d. deutsch. chem. Ges. **30**: 117–124. 1897.

This substance appears to have characters sufficiently different from the enzyms to entitle it to be placed in a distinct class of compounds. It seems probable, although not yet proven, that the yeast cell excretes the zymase into the surrounding liquid, and that the fermentation takes place outside of, and not within the living cell.

From the results so far obtained it appears safe to conclude that alcoholic fermentation is brought about by a non-living substance allied to the enzyms, and that the process is entirely distinct from both intramolecular and normal breathing. Further research along this line will undoubtedly bring to light other important discoveries.—J. C. A.

CAPTAIN HENRY D'ALBERTIS in 1893 equipped the "Corsaro," and on June 3 sailed from Genoa, following as closely as possible the course of Columbus in his voyage of discovery, and on July 20 reached the island of Guanahani,[7] called also San Salvador or Watling. The algæ collected were given to Professor Anthony Piccone for study, whose paper[8] is a useful contribution to phycogeography. Captain d'Albertis collected *Dasycladus occidentalis* Harv. and *Acetabularia crenulata* Lamour, in the interior salt lake of Guanahani. On July 21 he collected in the Atlantic, fifty miles off the mouth of the Delaware river, floating specimens of the following species: *Sargassum bacciferum* (Turn.) Ag., *S. vulgare* Ag., *S. filipendula* Ag., *Fucus vesiculosus* L., *Ascophyllum nodosum* (L.) Le Jol., *Jania rubens* (L.) Lamour (on the frond of *S. filipendula*). *Ascophyllum nodosum* was also collected in the Gulf Stream 150 miles S. E. of the Grand Banks of Newfoundland, and at 42° 6′ N. lat. and 46° 30′ W. long. Between New York and the Azores, d'Albertis collected *Sargassum Hystrix* J. Ag., *S. bacciferum* (Turn.) Ag., *S. cymosum* Ag., *Fucus vesiculosus* L., and *Ascophyllum nodosum* (L.) Le Jol.—DE TONI.

DR. G. KRAUS differs from the usually accepted view that calcium oxalate is a waste product of plant metabolism, and contends that it frequently plays the rôle of a reserve material.[9]

Finding by quantitative chemical analyses that the calcium oxalate present in roots of *Rumex obtusifolius* undergoes no noticeable diminution during the formation of its tall shoots in ordinary soil under usual conditions, he transplanted roots in early spring into pots containing in one case pure sand, and in the other case sand mixed with an abundance of calcium salts, and grew the plants in darkness to create the maximum demand on their reserves.

[7] That is, the true Guanahani, the first American island discovered by Columbus, not to be confounded with the false Guanahani or Cat, which is between Watling and Eleuthera.

[8] PICCONE, A.—Nota su alcune Alghe della Campagna del "Corsaro" in America. Atti della Società ligustica di Scienze naturali e geografiche **7**:—. 1896. [fasc. 4.] Genoa.

[9] DR. GREGOR KRAUS, Flora **83**: 54–73. 1897.

After two months analysis showed a marked loss of the calcium oxalate in the roots cultivated in pure sand, and but little decrease in the roots grown in the sand containing calcium. He concludes the oxalate here was drawn on to supply a demand for calcium.

The conduct of calcium oxalate in stems and branches was also investigated. In this connection analyses of barks with reference to the distribution of oxalate are of interest. The bark from trunks and branches of several trees gave uniformly a largely increasing amount of oxalate as one passes inward toward the cambium, the extremes in the oak being 4.96 per cent. in the outer cortex in the autumn, and 11.03 per cent. in the inner parts.

Analyses made at different times in the growing season showed that during the development of the buds the amount of calcium oxalate in the bark undergoes a marked decrease. The loss resulting from spring development was found to range between 12 and 42 per cent. of the amount present in the winter. This is accepted as evidence that calcium oxalate is made use of during the season of spring activity.

The solubility of calcium oxalate in various plant acids was tested and found to be considerable in concentrations varying from 0.1 to 0.001 per cent. Crystals examined after treatment presented a corroded appearance.

The author regards the water stream passing upward from the roots through the stem as the dissolving medium, and sees in the large calcium content often observed in the sap of trees a confirmation of this view.—RODNEY H. TRUE.

THE ECOLOGICAL RELATIONS of the underground systems of plants have been too little regarded, in spite of the fact that many of the most significant adaptations are of a subterranean nature. Rimbach's former studies[10] on underground stems and their methods of becoming deeply placed have been supplemented by a more comprehensive recent study.[11] In the meantime Areschoug has written a paper upon the same subject.[12] Areschoug has introduced the term "geophilous" plants, meaning those plants whose shoots persist in the soil, the antithetical term "aerophilous" denoting such plants as have aerial shoots. The geophyte condition is an adaptation against climatic extremes; annuals die when the dry or cold season advances, trees and shrubs protect themselves by lignification, while most perennial herbs

[10] Biologie der Pflanzen mit unterirdischem Sprosse. Ber. d. deutsch. bot. Ges. **13**: 141–155. 1895. Tieflage unterirdisch ausdauernder Pflanzen. Ber. d. deutsch. Bot. Ges. **14**: 164–168. 1896.

[11] Lebensweise der geophilen Pflanzen. Ber. d. deutsch. bot. Ges. **15**: 92–100 1897.

[12] Beiträge zur Biologie der geophilen Pflanzen. Acta Reg. Soc. Phys. Lund. T. 6. 1896. See Bot. Cent. **68**: 20–24. ——.

seek protection by ceasing aerial activities and remaining essentially dormant within the soil. Areschoug divides the geophytes into tufted perennials, rosette perennials, perennials with much branched base, bulb perennials, and rhizome perennials. The tufted and rosette types are not true geophytes, but are transitional forms. The third type sends up an aerial shoot the first season; this shoot dies down to the surface, and the next year branches from the base at several points; ultimately the basal parts are quite complex. Bulbous and rhizomatous plants represent the typical geophytes. Monocotyls have worked out better geophilous adaptations than have dicotyls. One of the important functions of geophilous plants is to store up a reserve food supply in the roots, stems or leaves. Plants with horizontal axes wander from year to year, more commonly in a straight line, though sometimes in a circle (orchids). Many plants become more deeply placed year by year. This burying is effected (1) by a downward growth of the stem, in which case the old stem parts are left behind; (2) by root contraction, in which case the plant is pulled down into the soil as a whole; or (3) by the intercalary growth of the petiole. Plants seem to have the power of self regulation, burying rapidly if put in shallow soil, slowly if put in deep soil. Rimbach considers this to be a matter of reciprocal action between leaves and roots; deep stems use up more energy in getting to the light and have a shorter period for assimilation, hence less energy can be expended in the work of burying deeper.—H. C. C.

THE ANNUAL REPORTS of a few of the Experiment Stations contain valuable botanical matter in addition to that issued through the bulletins. L. R. Jones, in the Vermont Report for 1895 (pp. 66–115), writes on potato blights, potato scab, oat smut, onion mildew, making and use of Bordeaux mixture, with many valuable original observations and deductions. W. C. Sturgis, in Connecticut Report for 1895 (pp. 166–190), writes on potato scab, onion smut, plum leaf curl, and notes on other diseases. S. M. Bain, in the Tennessee Report for 1896 (pp. 16–19), gives notes upon plant diseases observed within the state. B. D. Halsted, in the New Jersey Report for 1895 (pp. 247–361), and also in the Report for 1896 (pp. 287–429), records observations upon a large number of plant diseases, the fungi causing them, and on trials of fungicides, together with some other matters of botanical interest.—J. C. A.

MR. G. N. CALKINS finds tetrad formation and a reduction division in two ferns, *Pteris tremula* and *Adiantum cuneatum*.[13] The mitosis of the spore mother cells was studied, and the author finds that the chromosomes in both divisions behave in general as has been described by Häcker, Rückert, and vom Rath, for the maturation divisions in a number of animals. The reduction in the number of the chromosomes before the first division is a "pseudo-reduction," and in the second division we have probably only a transverse and no longitudinal splitting of the chromosomes.

[13] Bulletin of Torrey Bot. Club 24. 1897.

The author uses largely the terminology of spermatogenesis in animals to describe the well known stages in spore development. The desirability of this innovation is perhaps questionable. We have come to use, to be sure, a common nomenclature for many stages in the vegetative mitosis of both plant and animal cells, but until the significance of the processes in the sporange and the ovary and testis are better understood it is perhaps best not to insist too much on the value of apparent analogies. Spore development and reduction of the chromatin are undoubtedly associated with alternation of generations in plants, and until it is settled whether a similar relation exists in animals a separate terminology is desirable. The author expresses much surprise that "such obvious structures as tetrads should have been hitherto overlooked in the plant reproductive cells." This is, however, merely a question of name, since he does not dispute the accuracy of the figures for the lilies as given by Farmer, Strasburger, and others. The term is certainly not very applicable to the figures in lilies, where the contraction of the chromosomes in the prophases does not go so far as to reduce them to almost spherical shape as in the ferns. This fact probably makes the lilies more favorable for the study of reduction than are the ferns. The existence of "tetrads" can hardly be regarded as settling the question of a reduction division in Weismann's sense. Mottier, in the latest paper on the lilies, admits that two interpretations of the figures are possible, and that the occurrence of a longitudinal splitting of the chromosomes in the second division is not absolutely excluded.—R. A. H.

THOSE INTERESTED in the physiology of the fungi will find record of a large number of experiments by Alfred Lendner upon some Mucorini and conidial forms of Ascomycetes in *Annales des Sciences Naturelles* (Bot.) VIII. 3: 1—64. 1897. His investigations were addressed to the question of the combined influences of light and the substratum upon the development of the fungi which were selected haphazard. The results have proved very variable not only in the two groups, but even in the same species, so that no general conclusions have been reached.—C. R. B.

H. TITTMANN has studied the formation and regeneration of periderm, epidermis, wax-coverings and cuticle in various plants.[14] His researches were conducted at Leipzig, under the direction of Professor Dr. Pfeffer.

The effect of increased pressure upon the formation of the periderm was investigated by means of gypsum bands surrounding young twigs of various woody dicots. This produces a retardation of cork development, but does not suppress it, as Newcombe had already shown,[15] the cork cells departing only slightly in number and form from those produced under normal conditions.

[14] Jarhrbücher f. wiss Botanik 30: 116–154. 1897.

[15] BOT. GAZ. 19: 149. 1894.

The regeneration of the periderm is not prevented by the checking of secondary thickening. In the open twigs from which the periderm was sliced replaced it from the cortical parenchyma, though the number of cells was not so great as the normal, except in *Sambucus nigra* in which they were more numerous. In a moist atmosphere the exposed cortical cells grew into long tubes, forming a callus, from which the periderm was produced.

No regeneration of epidermis was observed, but its removal was followed by the formation of cork or of callus and then cork.

Wax coverings were replaced in only three plants observed, *Ricinus communis*, *Rubus biflorus*, and *Macleya cordata*, and then only when the plants were still in vigorous growth. Several sedums and echeverias examined did not secrete wax after it had been removed. Light produced no effect upon this process, and moist air diminished, but did not entirely prevent it.

The removal of the cuticle could only be accomplished upon leaves with a very thick outer epidermal wall, such as the agaves and aloes possess. When sliced off it was reformed, even in the moist air, in which, however, it was thinner. Filaments of *Cladophora glomerata* were cut into pieces (which do not grow longer) and cultivated for four weeks. The transverse walls, now exposed, became covered with a cuticle. Typical water plants, like *Ceratophyllum demersum* and *Elodea Canadensis*, could not thicken the cuticle on exposure to air, so that it was impossible to cultivate them under new conditions. Even the submersed leaves of *Nuphar luteum* and *N. advena* could not live as floating leaves. On the contrary the water leaves of *Sagittaria sagittifolia* and *Hippuris vulgaris*, upon exposure to air, lived and thickened the cuticle strongly. Some land plants (*Mentha aquatica*, *Polygonum Hydropiper* and *Lysimachia nummularia*) easily adapted themselves to a submersed life, forming then only a very delicate cuticle as a result of diminished transpiration.

The delicate membrane covering the cells bordering upon the large intercellular spaces of many water plants (and some land plants also), designated as cuticle by Frank, reacts to increased transpiration, becoming partly lifted up from the cell walls into blisters or considerably thickened. Whatever its nature it is certainly not equivalent to the true cuticle.—C. R. B.